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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/885,744	06/20/2001	Hiroaki Niimi	TI-32705	5587

23494 7590 08/19/2003

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EXAMINER

NGUYEN, KHIEM D

ART UNIT PAPER NUMBER

2823

DATE MAILED: 08/19/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/885,744

Applicant(s)

NIIMI ET AL.

Examiner

Khiem D Nguyen

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-- The MAILING DATE of this communication appears on the cover sheet with the corresponding address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 11 June 2003.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-7 and 9-16 is/are pending in the application.
- 4a) Of the above claim(s) 14-16 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-7 and 9-13 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 01 September 2001 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____
- 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other:

DETAILED ACTION

Response to Amendment

Response to Applicant's Arguments

Applicant's arguments filed 06-11-2003 have been fully considered but they are not persuasive.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 1-7 and 9-13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Huang et al. (U.S. Pub 2002/0146914) in view of Daniel et al. (U.S. Patent 6,235,590) and Park et al. (U.S. Pub 2001/0027004).

Huang discloses a method for forming an integrated circuit structure, comprising the steps of (FIGS. 1-5 and related text):

providing a substrate 11 having a semiconductor surface (page 2, paragraph [0018]);

forming an oxygen-containing layer 104 on the semiconductor surface wherein the oxygen containing layer is an ultra-thin silicon dioxide layer in the thickness range about 1.5 nm such that the oxygen-containing layer is an oxynitride layer and wherein the step of forming an oxide is a rapid thermal oxidation; and subsequently

re-oxidizing the layer by a rapid anneal step in a mixture of N₂O and H₂ wherein the anneal steps comprises 20 s or more at 1050 °C in N₂O/H₂, flowing at lower than 10 Torr (page 2, paragraph [0019]) and wherein N₂O/H₂, mixture contains less than 1 atomic % H₂ with the balance N₂O (page 2, paragraphs [0021] and [0022]);

Huang fails to explicitly disclose forming a uniform nitrogen distribution throughout the oxygen-containing layer as recited in present claim 1.

Daniel discloses forming a uniform nitrogen distribution throughout the oxygen-containing layer (col. 2, lines 39-42) and a method for forming an integrated circuit structure includes a transistor having a conductive gate structure 30 disposed on a gate dielectric layer 18 wherein the conductive gate is comprises of doped poly-silicon and wherein the gate dielectric is an ultra-thin silicon dioxide and further comprising the steps of forming source and drain 22 and their respective contact to complete the transistor (col. 2, line 58 to col. 3, line 39 and FIG. 1). It would have been obvious to one of ordinary skill in the art of making semiconductor devices to combine the teaching of Huang and Daniel to enable a uniform nitrogen distribution throughout the oxygen-containing layer of Huang to be formed and further more to improve performances of the devices.

Huang fails to explicitly disclose re-oxidizing the oxygen-containing layer by a rapid anneal step in an oxidizer and hydrogen mixture of N₂O and H₂ for stabilizing the nitrogen distribution at minimum oxidation rate, healing plasma-induced damage and reducing interfacial defect density as recited in present claim 1. However, the disclosed process above would obtain the recited results because the same materials are treated in

the same manner as in the instant invention. Alternatively, the steps could be employed in a process where the recited results are obtained. The claim does not require obtaining the results recited in use of "for".

Neither Huang nor Daniel discloses wherein the integrated circuit structure includes a capacitor having a capacitor dielectric as recited in present claim 13.

Park et al. discloses an integrated circuit structure includes a capacitor having a capacitor dielectric and further comprising the steps of (See col. 1, paragraph [0018] and FIG. 1):

forming a first electrode 5 over the substrate 1, the semiconductor surface present at the first electrode; and

forming a second electrode 9 on the dielectric layer 7 wherein the dielectric layer forms the capacitor dielectric. It would have been obvious to one of ordinary skill in the art of making semiconductor devices to combine the teaching of Huang, Daniel and Park et al.'s to enable the capacitor having a capacitor dielectric of Huang to be formed and further to reduce the leakage current density (col. 1, paragraph [0008]).

Response to Amendment

Response to Applicant's Arguments

Applicant's arguments filed 06-11-2003 have been fully considered but they are not persuasive.

In response to Applicant's argument that the first embodiment of Huang's process begins with the use of N₂O and H₂ to grow a gate dielectric consisting of silicon oxynitride but in Applicant's process, only the final anneal step uses N₂O and H₂,

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examiner disagree, Huang discloses implementing nitridation on the clean surface of the silicon substrate (FIG. 4, 401) before introducing a gas mixture comprising N₂O and H₂ into the process chamber at a low pressure lower than 10 torr (FIG. 4, 402), heating the nitrided surface of the silicon substrate to a temperature about 800-1000° C (FIG. 4, 403), and thermally growing a oxynitride (SiO₂-xN_x) layer on the silicon substrate (FIG. 4, 404). Thus, Huang uses the N₂O and H₂ in the final anneal step (page 2, paragraphs [0021]-[0023]).

In response to Applicant's argument that Huang's process forms a dielectric layer containing only 1-5 atomic % nitrogen whereas Applicant's process forms a dielectric layer containing about 10 atomic % atomic nitrogen, the Applicants then concluded that Huang clearly teaches that his nitrogen content is not uniform, examiner disagree, note that, there is no evidence indicating the range of the atomic % nitrogen is critical and it has been held that it is not inventive to discover the optimum or workable range of a result-effective variable within given prior art conditions by routine experimentation. See MPEP 2144.05. Furthermore, on pages 3-4 of the Office Action mailed on March 13, 2003, the examiner realized that Huang fails to explicitly disclose forming a uniform nitrogen distribution throughout the oxygen-containing layer as recited in present claim 1, however, Daniel et al. (U.S. Patent 6,235,590) is being used as a secondary reference to disclose forming a uniform nitrogen distribution throughout the oxygen-containing layer (col. 2, lines 39-42). The examiner also stated that it would have been obvious to one of ordinary skill in the art of making semiconductor devices to combine the teaching of Huang and Daniel to enable a uniform nitrogen distribution throughout the oxygen-

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containing layer of Huang to be formed and further more to improve performances of the devices (col. 2, line 42).

Conclusion

THIS ACTION IS MADE FINAL. Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the mailing date of this final action.


Any inquiry concerning this communication or earlier communications from the examiner should be directed to Khiem D Nguyen whose telephone number is (703) 306-0210. The examiner can normally be reached on Monday-Friday (8:00 AM - 5:00 PM).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached on (703) 306-2794. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 746-9179 for regular communications and (703) 746-9179 for After Final communications.

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Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

K.N.
August 15, 2003



Supervisory Patent Examiner
Technology Center 2800